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WRITTEN COMMAND

FIELD OF THE INVENTION

The present invention relates to a handheld elec-
tronic device which is adapted to carry out at least one
operation. The invention also relates to a method for
5 initiating an operation in a handheld electronic device,
as well as a computer program.

BACKGROUND ART

Handheld computers and other handheld electronic
devices, such as mobile telephones, PDAs, reading pens,
10 and scanners, are usually controlled by means of one or
several buttons or keys, with the aid of which a user
issues various commands to the device or inputs informa-
tion which the device is to use. If there are only a few
buttons, controlling the device is usually complicated
15 and time-consuming. On the other hand, if there are many
buttons/keys they are usually small in order to only
require a small amount of space on the handheld device,
which makes them inconvenient to use and increases the
risk of pressing the wrong button/key.

20 US 5,852,434 discloses a device which enables a user
to input hand-written and hand-drawn information to a
computer while the information is being written/drawn
on the writing surface. The device comprises a writing
surface, on which a position code is arranged for coding
25 X/Y coordinates of positions on the surface, and a
special pen with a writing tip by means of which the user
can write or draw on the writing surface. Furthermore,
the pen has a light source for illuminating the position
code and a CCD sensor for forming an image of the
30 position code. The positional information received by the
CCD sensor is transferred to a computer for processing.

WO 99/48268 discloses a handheld device for writing
a telephone number and sending the number to a mobile
telephone for automatic dialing.

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SUMMARY OF THE INVENTION

An object of the present invention is to simplify the control and operation of a handheld device.

This object is completely or partly achieved by a device according to claim 1, a computer program according to
5   to claim 16, and a method according to claim 17 or 18. Preferred embodiments are defined in the subclaims.

According to a first aspect, the invention relates to a handheld electronic device adapted to carry out at least one operation, the device being controllable by a
10 user using the device as a pen and writing a command for initiating said operation.

An advantage of the invention is thus that the user is not required to press any keys or buttons on the device. Instead, he controls the device by writing
15 a command for the operation he wishes to carry out. This makes the device more convenient to use for the user.

The command written by the user can, for example, be a word indicating the operation which is to be carried out, for example "Dial" if the user wants the device to
20 dial a certain number. It can also be a symbol, a character, a number, or a figure indicating the operation which is to be carried out.

The device can record the command written by means of the device in different ways, for example by using one
25 or more sensors which detect the movement of the device.

However, in a preferred embodiment, the device is adapted to record the command by detecting a position code located on a writing surface upon which the command is written.

30 This embodiment is advantageous since it makes it possible to determine the absolute position of the device on the writing surface, which enables an exact recording of the written command. More specifically, the position code can be detected continuously while the command is
35 being written, a sequence of position indications being

obtained which define how the device has been moved and
thus which command has been written.

The device can use different types of sensors
depending on the technology used to implement the posi-

5   tion code. In a preferred embodiment, the position code
is designed in such a way that it can be detected by an
optical sensor. In this case, the device advantageously
comprises an optical sensor which is adapted to record
images of the writing surface, and a signal processor

10 which is adapted to use the position code in the images
for providing a digital representation of the command.

This embodiment is advantageous because it is bas-
ed on image processing, which is a well-known and well-
developed technology.

15 The signal processor may comprise an interpretation
function for recognizing a command symbol. Thus, the user
may define an arbitrary symbol as a command symbol and
when writing this symbol, the device interprets the
symbol as a command.

20 One example would be the character @, which may be
interpreted as a command that the following characters
are to be interpreted as an e-mail address. By writing
the command symbol @ once again, after the e-mail address
(thus for the third time), it is interpreted as the end

25 of the input of the e-mail address.

Moreover, the signal processor may comprise a char-
acter interpretation function which is adapted to trans-
late the digital representation of the command into
character-coded format. This embodiment is advantageous

30 because it makes it easier to determine which command the
user has written and available software for character
recognition may be used for interpretation of the
command. The character interpretation operation can, for
example, be carried out by ICR software.

35 Furthermore, the device can be adapted to record a
message information quantity which is used in the
operation and recorded in essentially the same way as the

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command. In this way, the user will have the same
interface for controlling the device and for inputting
message information. The device will be less expensive to
produce if the same means are used for inputting message

5   information.

The message information quantity can, for example,
be a text which is to be transmitted in an e-mail
message, a telephone number which is to be dialed, an
entry which is to be made in a calendar program or some

10   other similar information quantity. It can comprise text,
numbers, various types of characters, symbols, figures,
drawings, and other information which can be generated by
means of "hand-writing", which is defined as any manual
movement of the device on a surface.

15   In a preferred embodiment, the message information
quantity is also recorded by detecting the position code
on the writing surface.

The device can have at least two modes, one being
a command mode for recording the command and the other

20   being an information mode for recording the information
quantity. By virtue of the fact that it has different
modes the device knows how the data that is written by
means of the device should be processed and there is no
doubt about whether the data is a command or a message

25   information quantity.

In one embodiment, the device assumes the command
mode when a predetermined command symbol is written
with the aid of the device. This command symbol can be
a figure, one or several characters, a picture or the

30   like.

In another embodiment, the device assumes the com-
mand mode when it detects that the writing surface has
a special design. The writing surface can, for example,
have a special area for writing commands and another area

35   for writing the information quantity, the device detect-
ing on which area it is located with the aid of the posi-
tion code.

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The principle according to the invention can be used
for causing a handheld electronic device to carry out any
operation which can be initiated by means of a command.
Examples of operations that are carried out in handheld
5   electronic devices include dialing, faxing, sending an
electronic message, saving information, managing docu-
ments and files, and starting, controlling and closing
programs. An operation may or may not be an operation
which utilizes a message information quantity.

10   In an advantageous embodiment the device is a mobile
telephone, which can thus be controlled by a user using
the telephone as a pen, for example writing "dial
1234567", whereupon the telephone automatically dials
that number.

15   In an alternative embodiment the device comprises
an accelerometer for recording the command. The accelero-
meter records the movement of the device when the command
is being written. This embodiment has the advantage that
the command can be written on any surface or even in the
20   air, without contact with a surface. Accordingly, there
is no need for a writing surface with a position code
and, in fact, there is no need for a writing surface at
all; rather, the command can be "written" on any arbi-
trary surface.

25   In yet another alternative embodiment, the device
comprises an optical sensor for recording images with
partially overlapping content and a signal processor
which is adapted to determine how the device has been
moved in connection with the writing of the command by
30   determining the relative position of the images.

This embodiment also has the advantage that no
position code is required; rather, the user can "write"
the command with the aid of the device on any surface
which is sufficiently patterned to enable the determi-
35   nation of the relative position of the images. The tech-
nology for determining what has been written is described
in more detail in publication WO 99/60467, the contents

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of which is incorporated in the present specification by reference. This method for recording a command can advantageously be used for controlling a reading pen or a handheld scanner of the type described in the publication

5   WO 98/20446, the contents of which is incorporated in the present specification by reference, and sold under the trademark C-Pen[®].

The device need not be one integrated unit. In one embodiment, the device can have a first and a second

10   part which are separable and which have transceivers for mutual wireless or wirebound communication, the device being controllable by the user using the first part as said pen, by means of which said command for initiating the operation is written.

15   According to a second aspect of the present invention, it relates to a computer program, which is stored on a memory medium, which can be read by a computer, and which comprises instructions for causing the computer to detect a command written by means of a handheld electro-

20   nic device which is being used as a pen and initiate a predetermined operation in response to the command. The advantages of this software are evident from the above discussion. The software is designed to be installed in the device by means of which the command is written.

25   According to a third aspect of the present invention, it relates to a method for initiating an operation in a handheld electronic device comprising the steps of using the device itself as a pen and writing a command for carrying out said operation.

30   The advantages of the method are evident from the above discussion.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in more detail below with reference to the accompanying drawings, in which

35   Fig. 1 is a partial, schematic cross-sectional view of an embodiment of a handheld device according to the invention;

Fig. 2 is a plan view of a writing surface provided with a position code and which can be used for recording written commands; and

Fig. 3 is an isometric view of a second embodiment
5   of a handheld device according to the invention.

Fig. 4 is a schematic diagram of a product provided with an alternative position coding pattern.

Fig. 5 is a schematic diagram disclosing how the markings may be designed and positioned in the position
10   code pattern of Fig. 4.

Fig. 6 is a schematic diagram of a code pattern in which 4*4 symbols are used for coding a position.
DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION

Fig. 1 discloses a handheld device in the form of a digital pen, which can be used for writing text and
15   drawing lines and pattern or symbols which are to be recorded in digital format. The device is controlled by the user by writing commands with the pen for the operations which are to be carried out.

The device comprises a casing 11 having approximate-
20   ly the same shape as a pen. At one short side of the casing there is an opening 12 or a window which is transparent for IR light. The short side is intended to abut against or be placed a short distance from a writing surface 3 during operation of the device, see Fig. 2.
25   The casing 11 essentially comprises an optics part, an electronic circuitry part, and a power supply. The optics part comprises at least one light-emitting diode 13 for illuminating the surface which is to be imaged and a light-sensitive area sensor 14, such as a CCD or CMOS
30   sensor, for recording a two-dimensional image. The user unit may also comprise a lens system (not shown).

The power supply to the device is obtained from a battery 15, which is mounted in a separate compartment in the casing 11. The battery may be a chargable battery.

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Alternatively, the power supply is obtained via a
cable connection with a separate device, comprising a
power source.

The electronic circuitry part comprises a signal
5   processor 16. The signal processor 16 is implemented
with the aid of a microprocessor and a memory and
contains software for analyzing images from the sensor
for providing a digital representation of what is being
written on the writing surface 3. Furthermore, it
10   contains operation software for initiating and/or
carrying out various operations in response to commands,
as well as user software. Moreover, the signal processor
16 advantageously contains ICR software which can be used
for interpreting the recorded characters so that they can
15   be stored, manipulated, and/or forwarded in character-
coded format.

The casing 11 of the device also comprises a pen
point 18, with the aid of which the user can write ordi-
nary pigment-based writing on the writing surface 3. The
20   pen point 18 is extendable and retractable so that the
user can control whether or not it is to be used. The
pigment is preferably non-absorbing for IR light.

Moreover, the device comprises buttons 19 by means
of which the device can be activated and controlled for
25   operations which are not initiated by commands written by
means of the device. The buttons 19 can also be used for
causing the device to assume different modes, as well as
an on/off switch.

It may also comprises a transceiver 20 for wireless
30   transfer, for example by means of IR light, ultrasound or
radio waves, of information over short distances. This
wireless transfer can be utilized when the device cannot
itself carry out the whole initiated operation and needs
to forward the recorded information quantity and informa-
35   tion about the operation to be carried out to an external
unit.

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Finally, the device may comprise a display 21 for showing information.

The above-mentioned publication WO 98/20446 discloses a device for scanning and recording text. If

5   programmed in a suitable way, this device can be utilized for recording text and commands which are being written on a writing surface provided with a position code, and for initiating/carrying out operations in response to the written commands.

10   Fig. 2 shows a sheet of paper 1 defining a writing surface 3. On the writing surface 3 there is printed a position code 4, which is composed of symbols 5 of a first and a second type 5a, 5b and more specifically a dot having a larger radius and a dot having a smaller

15   radius, corresponding to a "one" and a "zero" respectively. For the sake of clarity, the symbols 5 have been enlarged and the position code 4 is only shown on a small part of the writing surface 3. In a real embodiment the position code extends across the entire writing surface 3

20   and the symbols 5 are smaller to ensure better position resolution.

The position code 4 can be created in a number of different ways. One way of creating a position code 4 in which each position is coded with one symbol 5 is

25   described in US 5,852,434. However, in the present invention, each position is advantageously coded with the aid of a plurality of symbols 5 and the coding is such that each symbol 5 in the position code 4 contributes to the coding of more than one position, so called floating

30   coding. This means that two adjoining positions share some symbols 5, as indicated in Fig. 1 by the dashed areas 6a, 6b. In this way, a higher resolution is achieved and the detection becomes easier since the individual symbols 5 can be less complex. This type of

35   overlapping or floating position code 4 can be created with the aid of a computer.

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A special way of generating such a floating position
code is described in the publication WO 00/73983, the
contents of which is incorporated in the present
specification by reference, and patent applications Nos.

5   PCT/SE00/001895, PCT/SE00/001897 and PCT/SE00/001898 all
filed October 2, 2000, the contents of which are
incorporated in the present specification by reference.

The operation of the device in Fig. 1 will now be
described.

10   Suppose that a user wishes to make an entry in a
calendar program in the device. In this case, he must
first open the calendar program. In order to cause the
device to carry out this task, the user first writes a
special command symbol and subsequently the command

15   letters "calendar" on the sheet of paper 3 using the pen
point 17. The command symbol may be any symbol that the
user has defined to be a command symbol, for example a
large circle like "O" inside which is written a small
circle like "o", more or less in one pen stroke, like the

20   following:

While the user is writing, the optical sensor 14
continuously captures images of the writing surface 3
in the current position of the device. Each image con-
tains a part of the position code 4. The signal proces-

25   sor 16 localizes the position code 4 in each image and,
on the basis of this code, determines the coordinates of
the absolute position on the writing surface 3 in which
each image was captured. In this way, a description, in
the form of a large number of position indications, is

30   obtained of how the pen has been moved across the sheet.
This description constitutes a digital representation of
the command symbol and the command. The position indica-
tions are fed as an input signal to the ICR software,
which determines the characters to which the positions

35   correspond, so that the command symbol and the command
can be translated into character-coded format. The

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command may be ended by once again entering the command
symbol.

When the processor detects the command symbol it
knows that the characters that follow should be inter-
5 preted as a written command. The processor then compares
the characters representing the recorded command with a
number of predetermined commands to determine which com-
mand the user has written. When it has determined that
the command is a command for opening the calendar pro-
10 gram, it carries out the operation of opening the calen-
dar program. The program can, for example, show a day in
the calendar on the display 21 in the usual way.

The user moves a cursor to the time where the entry
should be made. Subsequently, the user writes the entry
15 he wishes to make on the sheet of paper 3 using the pen
point 17. The device records the entry in the same way as
the command. Since the processor does not detect the com-
mand symbol it knows that the written characters repre-
sent an information quantity. The characters are trans-
20 lated into character-coded format with the aid of the ICR
software and are stored in the calendar program.

Next, the user wishes to save and close the program.
To this end, she writes the command symbol followed by
the command "save". The written command is processed in
25 the same way as the command "open" and results in the
execution of the operation of saving the written entry.

After the execution of a command, the device reverts
to its normal input mode, until the next command symbol
is entered.

30 It should be noted that the pen point 17 is only
used in order to make it easier for the user to see what
he is writing. It has no other function.

Fig. 3 schematically shows another embodiment of a
device according to the invention. In this example, the
35 device is an ordinary mobile telephone 30 supplemented
with new software, a transceiver 31 for wireless commu-
nication over short distances, and a pen 32 for control-

ling the telephone. When the pen is not in use it is placed in a holder 33 on the side of the telephone. The holder may comprise a contact for connecting the pen to the battery of the mobile telephone for charging the pen

5   battery. Alternatively, the pen battery may be charged at the same time as the telephone battery is charged by a battery charger. The charging circuitry of the telephone may be used for controlling the battery charge of the pen as well.

10   The holder may further comprise connectors for connecting the pen to the electronic circuitry of the telephone, so that the pen may download its memory contents to the telephone, or transmit its memory contents to a network using the telephone as a modem.

15   The structure of the pen 32 is essentially the same as that of the device in Fig. 1. However, it has no display, no mobile telephone transceiver, and only part of the software in the device in Fig. 1.

    When the user wishes to telephone, for example, she
20 detaches the pen and writes "dial" using the pen on a sheet of paper with a position code. She circles the word "dial" to indicate that it is a command. Subsequently, she writes the telephone number that is to be dialed. The pen records images of the position code on the sheet and
25 transfers these images by the intermediary of a transmitter 34 for wireless communication over short distances to the transceiver 31 in the mobile telephone. The images received are processed in the mobile telephone in the same way as described above with reference to Fig. 1,
30 the result being that the mobile telephone carries out the operation of dialing the number indicated.

    Alternatively, the optical sensor in the pen 32 can be integrated with the mobile telephone and the whole mobile telephone can be used as a pen for writing com-
35 mands.

    Another alternative is that the pen performs all actions and operations, and when the telephone number is

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recognised and decoded to ASCII, the pen sends the
telephone number to the telephone for initiating the
call, or transmits the telephone number to the telephone
via the above-mentioned connectors.

5   As an alternative to the above embodiment in which
the command is indicated by means of a special character
or figure, the devices can be switched between a command
mode and an information mode with the aid of the buttons
19.

10   In cases where the number of possible commands is
small, there is no need to specially indicate the com-
mands.

As mentioned above, the detection of the written
command can be based on other techniques than the detec-
15 tion of a position code, such as an accelerometer or the
recording of images with partially overlapping content
for determining the movement of the device. These
embodiments are not described in detail since the person
skilled in the art will have no difficulty modifying the
20 above device for the use of alternative techniques.

Finally, the preferred embodiment of the absolute
position-coding pattern will now be described. For the
sake of simplicity it is described in connection with a
sheet of paper. It corresponds to the absolute position-
25 coding pattern described in PCT/SE00/01895. It is
referred to as a position-coding pattern since a surface
to which the position code is applied gives a slightly
patterned impression.

Fig. 4 shows an enlarged part of a sheet which on
30 its surface 102 is provided with the position-coding
pattern 105. The sheet has an x coordinate axis and a y
coordinate axis.

The position-coding pattern comprises a virtual
raster which neither is visible to the human eye nor can
35 be detected directly by a device which is to determine
positions on the surface, and a plurality of symbols

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which each can assume one of four values "1" – "4" as
will be described below.

The position-coding pattern is arranged in such a
manner that the symbols on a partial surface of the sheet
5   of paper code absolute coordinates of a point on an ima-
ginary surface, which will be described below. A first
and a second partial surface 125a, 125b are indicated by
dashed lines in Fig. 4. That part of the position-coding
pattern (in this case 4 x 4 symbols) which is to be found
10 on the first partial surface 125a codes the coordinates
of a first point, and that part of the position-coding
pattern which is to be found on the second partial
surface 125b codes the coordinates of a second point on
the imaginary surface. Thus the position-coding pattern
15 is partially shared by the adjoining first and second
points. Such a position-coding pattern is in this
application referred to as "floating".

Figs 5a-5d show an embodiment of a symbol which can
be used in the position-coding pattern. The symbol com-
20 prises a virtual raster point 130 which is represented by
the intersection between the raster lines, and a marking
106 which has the form of a dot. The value of the symbol
depends on where the marking is located. In the Example
in Fig. 5, there are four possible locations, one on
25 each of the raster lines extending from the raster
points. The displacement from the raster point is equal
to all values. In the following, the symbol in Fig. 5a
has the value 1, in Fig. 5b the value 2, in Fig. 5c the
value 3 and in Fig. 5d the value 4. Expressed in other
30 words, there are four different types of symbols.

It should be pointed out that the dots can, of
course, have a different shape.

Each symbol can thus represent four values "1-4".
This means that the position-coding pattern can be divid-
35 ed into a first position code for the x coordinate, and
a second position code for the y coordinate. The division
is effected as follows:

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Symbol value	x-code	y-code
1	1	1
2	0	1
3	1	0
4	0	0

     Thus, the value of each symbol is translated into
a first digit, in this case bit, for the x-code and a
5 second digit, in this case bit, for the y-code. In this
manner, two completely independent bit patterns are
obtained. The patterns can be combined to a joint pat-
tern, which is coded graphically by means of a plurality
of symbols according to Fig. 5.

10   The coordinates for each point is coded by means of
a plurality of symbols. In this example, use is made of
4x4 symbols to code a position in two dimensions, i.e.
an x-coordinate and a y-coordinate.

     The position code is made up by means of a number
15 series of ones and zeros which have the characteristic
that no sequence of four bits appears more than once in
the series. The number series is cyclic, which means that
the characteristic also applies when one connects the end
of the series to the beginning of the series. Thus a
20 four-bit sequence always has an unambiguously determined
position in the number series.

     The series can maximally be 16 bits long if it is to
have the above-described characteristic for sequences of
four bits. In this example, use is, however, made of a
25 series having a length of seven bits only as follows:

               "0 0 0 1 0 1 0".

     This series contains seven unique sequences of four
bits which code a position in the series as follows:

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Position in the series	Sequence
0	0001
1	0010
2	0101
3	1010
4	0100
5	1000
6	0000

For coding the x-coordinate, the number series is
written sequentially in columns across the entire surface
that is to be coded. The coding is based on the

5   difference or position displacement between numbers in
adjoining columns. The size of the difference is deter-
mined by the position (i.e. with which sequence) in the
number series, in which one lets the column begin. More
specifically, if one takes the difference modulo seven

10   between on the one hand a number which is coded by a
four-bit sequence in a first column and which thus can
have the value (position) 0-6, and, on the other hand,
the corresponding number (i.e. the sequence on the same
"level") in an adjoining column, the result will be the

15   same independently of where along the two columns one
makes the comparison. By means of the difference between
two columns, it is thus possible to code an x-coordinate
which is constant for all y-coordinates.

Since each position on the surface is coded with

20   4x4 symbols in this example, three differences (having
the value 0-6) as stated above are available to code the
x-coordinate. Then the coding is carried out in such man-
ner that of the three differences, one will always have
the value 1 or 2 and the other two will have values in

25   the range 3-6. Consequently no differences are allowed

to be zero in the x-code. In other words, the x-code is structured so that the differences will be as follows: (3-6) (3-6) (1-2) (3-6) (3-6) (1-2) (3-6) (3-6) (1-2)... Each x-coordinate thus is coded with two numbers between

5   3 and 6 and a subsequent number which is 1 or 2. If three is subtracted from the high numbers and one from the low, a number in mixed base will be obtained, which directly yields a position in the x-direction, from which the x-coordinate can then be determined directly, as shown

10   in the example below.

By means of the above described principle, it is thus possible to code x-coordinates 0,1,2..., with the aid of numbers representing three differences. These dif-ferences are coded with a bit pattern which is based on

15   the number series above. The bit pattern can finally be coded graphically by means of the symbols in Fig. 5.

In many cases, when reading 4x4 symbols, it will not be possible to produce a complete number which codes the x-coordinate, but parts of two numbers. Since the least

20   significant part of the numbers is always 1 or 2, a com-plete number, however, can easily be reconstructed.

The y-coordinates are coded according to the same principle as used for the x-coordinates. The cyclic number series is repeatedly written in horizontal rows

25   across the surface which is to be position-coded. Just like in the case of the x-coordinates, the rows are allowed to begin in different positions, i.e. with dif-ferent sequences, in the number series. However, for y-coordinates one does not use differences but codes

30   the coordinates with numbers that are based on the start-ing position of the number series on each row. When the x-coordinate for 4x4 symbols has been determined, it is in fact possible to determine the starting positions in the number series for the rows that are included in the

35   y-code in the 4x4 symbols. In the y-code the most sig-nificant digit is determined by letting this be the only one that has a value in a specific range. In this exam-

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ple, one lets one row of four begin in the position 0-1
in the number series to indicate that this row relates
to the least significant digit in a y-coordinate, and the
other three begin in the position 2-6. In y-direction,
5   there is thus a series of numbers as follows:
(2-6) (2-6) (2-6) (0-1) (2-6) (2-6) (2-6) (0-1) (2-6)...
Each y-coordinate thus is coded with three numbers
between 2 and 6 and a subsequent number between 0 and 1.
      If 0 is subtracted from the low number and 2 from
10   the high, one obtains in the same manner as for the
x-direction a position in the y-direction in mixed
base from which it is possible to directly determine
the y-coordinate.
      With the above method it is possible to code
15   4 x 4 x 2 = 32 positions in x-direction. Each such
position corresponds to three differences, which gives
3 x 32 = 96 positions. Moreover, it is possible to code
5 x 5 x 5 x 2 = 250 positions in y-direction. Each such
position corresponds to 4 rows, which gives 4 x 250 =
20   1000 positions. Altogether it is thus possible to code
96000 positions. Since the x-coding is based on diffe-
rences, it is, however, possible to select in which posi-
tion the first number series begins. If one takes into
consideration that this first number series can begin
25   in seven different positions, it is possible to code
7 x 96000 = 672000 positions. The starting position of
the first number series in the first column can be cal-
culated when the x-coordinate has been determined. The
above-mentioned seven different starting positions for
30   the first series may code different sheets of paper or
writing surfaces on a product.
      With a view to further illustrating the function
of the position-coding pattern, here follows a specific
example which is based on the described embodiment of
35   the position code.
      Fig. 6 shows an example of an image with 4x4 symbols
which are read by a device for position determination.

These 4x4 symbols have the following values:

4 4 4 2

3 2 3 4

4 4 2 4

5   1 3 2 4

These values represent the following binary x- and y-code:

x-code:	y-code:
0 0 0 0	0 0 0 1
10 1 0 1 0	0 1 0 0
0 0 0 0	0 0 1 0
1 1 0 0	1 0 1 0

The vertical x-sequences code the following positions in the number series: 2 0 4 6. The diffe-

15   rences between the columns will be -2 4 2, which modulo 7 gives: 5 4 2, which in mixed base codes position (5-3) x 8 + (4-3) x 2 + (2-1) = 16 + 2 + 1 = 19. Since the first coded x-position is position 0, the difference which is in the range 1-2 and which is to be seen in the

20   4x4 symbols is the twentieth such difference. Since fur- thermore there are a total of three columns for each such difference and there is a starting column, the vertical sequence furthest to the right in the 4x4 x-code belongs to the 61st column in the x-code (3 x 20 + 1 = 61) and

25   the one furthest to the left belongs to the 58th.

The horizontal y-sequences code the positions 0 4 1 3 in the number series. Since these series begin in the 58th column, the starting position of the rows are these numbers minus 57 modulo7, which yields the starting

30   positions 6 3 0 2. Translated into digits in the mixed base, this will be 6-2, 3-2, 0-0, 2-2 = 4 1 0 0 where the third digit is the least significant digit in the number at issue. The fourth digit is then the most significant digit in the next number. In this case, it must be the

35   same as in the number at issue. (An exceptional case is when the number at issue consists of the highest possible digits in all positions. Then one knows that the begin-

ning of the next number is one greater than the beginning
of the number at issue.)

The position of the four-digit number will then in
the mixed base be $0x50 + 4x10 + 1x2 + 0x1 = 42$.

5   The third row in the y-code thus is the 43rd which
has the starting position 0 or 1, and since there are
four rows in all on each such row, the third row is num-
ber $43x4=172$.

Thus, in this example, the position of the uppermost
10   left corner for the 4x4 symbol group is (58,170).

Since the x-sequences in the 4x4 group begin on row
170, the x-columns of the entire pattern begin in the
positions of the number series $((2\ 0\ 4\ 6) - 169)$ modulo
$7 = 1\ 6\ 3\ 5$. Between the last starting position (5) and
15   the first starting position, the numbers 0-19 are coded
in the mixed base, and by adding up the representations
of the numbers 0-19 in the mixed base, one obtains the
total difference between these columns. A naive algorithm
to do so is to generate these twenty numbers and directly
20   add up their digits. The resulting sum is called s. The
sheet of paper or writing surface will then be given by
$(5-s)$modulo7.

In the example above, an embodiment has been
described, in which each position is coded with 4 x 4
25   symbols and a number series with 7 bits is used. Of
course, this is but an example. Positions can be coded
with a larger or smaller number of symbols. The number
of symbols need not be the same in both directions. The
number series can be of different length and need not
30   be binary, but may be based on another base. Different
number series can be used for coding in x-direction and
coding in y-direction. The symbols can have different
numbers of values. As is evident from the above, a coding
with 6 x 6 symbols is presently preferred, each symbol
35   being capable of assuming four values. A person skilled
in the art can readily generalise the above examples to
concern such coding.

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In the example above, the marking is a dot but may,
of course, have a different appearance. For example, it
may consist of a dash or some other indication which
begins in the virtual raster point and extends therefrom
5   to a predetermined position. As one more alternative, the
marking may consist of a rectangle, a square, a triangle
or some other convenient, easily detected figure. The
marking can be filled or open.

In the example above, the symbols within a square
10 partial surface are used for coding a position. The par-
tial surface may have a different form, such as hexago-
nal. The symbols need not be arranged in rows and columns
at an angle of 90° to each other but can also be arranged
at other angles, e.g. 60°, and/or in other arrangements.
15 They could also code positions in polar coordinates or
coordinates in other coordinate systems.

For the position code to be detected, the virtual
raster must be determined. This can be carried out by
studying the distance between different markings. The
20 shortest distance between two markings must derive from
two neighbouring symbols having the value 1 and 3 (hori-
zontally) or 2 and 4 (vertically) so that the markings
are located on the same raster line between two raster
points. When such a pair of markings has been detected,
25 the associated raster points can be determined with know-
ledge of the distance between the raster points and the
displacement of the markings from the raster points. When
two raster points have once been located, additional
raster points can be determined by means of measured dis-
30 tances to other markings and with knowledge of the rela-
tive distance of the raster points.

The position-coding pattern described above can code
a large number of unique positions and more specifically
the absolute coordinates of these positions. All the
35 positions or points that can be coded by means of the
position-coding pattern can be said to jointly make up
an imaginary surface. Different parts of the imaginary

surface can be dedicated to different specific purposes.
One area of the imaginary surface can, for instance, be
dedicated to be used as a writing surface, another as
a character recognition area and yet other areas as

5   various activation icons. Other areas of the imaginary
surface can be used in other applications. A correspond-
ing subset of the position-coding pattern can then be
used to create, for example, a certain activation icon
which can be arranged in an optional location on a pro-

10   duct. The coordinates coded by this subset of the posi-
tion-coding pattern thus do not relate to a position on
the product but to a position on the imaginary surface,
which position is dedicated always to correspond to this
activation icon.

15   In the presently preferred embodiment, the nominal
interspace between the dots is 0.3 mm. Any part whatever
of the position-coding pattern which contains 6 x 6 dots
defines the absolute coordinates of a point on the ima-
ginary surface. Each point on the imaginary surface is

20   thus defined by a 1.8 mm x 1.8 mm subset of the position-
coding pattern. By determining the position of the 6 x 6
dots on a sensor in a device which is used to read the
pattern, a position can be calculated by interpolation on
the imaginary surface with a resolution of 0.03 mm. Since

25   each point is coded with 6 x 6 dots which can each assume
one of four values, 2^{72} points can be coded, which with
the above-mentioned nominal interspace between the dots
corresponds to a surface of 4.6 million km^2.

        The absolute position-coding pattern can be printed

30   on any paper whatever or other material which enables a
resolution of about 600 dpi. The paper can have any size
and shape whatever depending on the intended application.
The pattern can be printed by standard offset printing.
Ordinary black carbon-based ink or some other ink which

35   absorbs IR light can advantageously be used. This means
in fact that other inks, including black ink which is not
carbon-based, can be used to superimpose other printed

text on the absolute position-coding pattern, without
interfering with the reading thereof.

    A surface which is provided with the above-mention-
ed pattern printed with carbon-based black ink will be
5   experienced by the human eye as only a slight grey shad-
ing of the surface (1-3% density), which is user-friendly
and aesthetically pleasing.

    Of course, a smaller or large number of dots than
described above can be used to define a point on the ima-
10 ginary surface and a larger or smaller distance between
the dots can be used in the pattern. The examples above
are only given to demonstrate a presently preferred
implementation of the pattern.